THE COST OF A KIA

by

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THESIS

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October 1969

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Submitted in partial fulfillment of the
requirement for the degree of

MASTER OF SCIENCE IN OPERATIONS RESEARCH

from the

NAVAL POSTGRADUATE SCHOOL
October 1969

ABSTRACT

This study presents, discusses, and offers a solution to the problem of estimating the cost of a KIA. The different aspects of life valuation are discussed in terms of losses that result to both the military and to society in general when a soldier is killed. These losses are further identified as to whether they fall into one of two categories, tangible or intangible. Although the study is mainly concerned with the tangible losses, a procedure is offered that will ensure inclusion of the intangible losses in the overall cost determination of a KIA. For the tangible losses, a mathematical model is developed for computing the economic loss of both an officer and enlisted KIA to society and to the military. The use of the model is demonstrated by way of three examples, the first of which determines the cost of an "average" KIA and the remaining two determine the upper and lower cost bounds. A limited sensitivity analysis is conducted on the model and the results and the impact of the analysis is presented. The study concludes with how the model can best be used by Department of Defense decision makers.

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TABLE OF SYMBOLS AND ABBREVIATIONS

AT	Accession Travel Cost
BP	Base Pay
BS	Officer Branch School Training Cost
BT	Basic Training Cost
CA	Initial Clothing Allowance
CB	Combat Pay
CC	Officer Commissioning Cost
CM	Clothing Maintenance Allowance
CONARC	Continental Army Command
FP	Flight Pay
FS	Family Separation Allowance
HD	Hazardous Duty Pay
IP	Induction Processing Cost
KIA	Killed In Action
LS	Length of Service
MOS	Military Occupational Specialty
OC	Operating Cost
OCS	Officer Candidate School
P	Probability of Surviving
PC	Procurement Cost
PP	Proficiency Pay
PV	Present Value of Lifetime Income

QA ..... Quarters Allowance

R ..... Discount Rate

RC ..... Recruiting Cost

ROTC ..... Reserve Officers' Training Corps

S ..... Subsistence Allowance

SS ..... Social Security Contribution

ST ..... Specialized Training Cost

TG ..... Total Training Cost

TR ..... Travel Cost

USMA ..... United States Military Academy

W, X ..... Economic Growth Factors

Y ..... Average Annual Income

I. INTRODUCTION

The topic discussed in this paper, the value of a soldier's life, is a delicate one, subject to much misinterpretation, and there are many who say the value of a human life cannot be measured. Nevertheless, whether recognized or not, the concept of life evaluation is regularly applied by every individual in many different ways. For example, the decision to cross a busy street is a subconscious decision, whereas the selection of a course of action by a military commander is a very deliberate and conscious decision. Why they are made and who makes them is not important, but what is important is the fact that they are made each time a life risk situation presents itself. The utility to be gained is measured, consciously or subconsciously, deliberately or intuitively, against the life risk faced.

Unfortunately, this concept of life evaluation is often neglected, and in many cases completely disregarded, by decision makers in industry, government, and the military. This is particularly true in economic analyses conducted by the Department of Defense and its agencies. Present defense studies treat the problem of life valuation in a haphazard manner. There is no standard procedure or technique available. Some consider replacement costs, some consider training costs, whereas others assign zero value through oversight, ignorance, or reluctance to undertake the problem. Whatever the reasons, decision makers are being forced to render crucial decisions based on incomplete analysis and are

having to fill the gaps with their intuitive judgment. This is not to imply that intuitive judgment is wrong and should not be used, but when it can be supplemented by sound quantitative analysis, then every effort should be made to do so. C. J. Hitch and R. N. McKean have more aptly stated the case as follows:

"Efficient techniques and policies have to be selected consciously; and whenever the relevant factors are diverse and complex, as they frequently are, unaided intuition is incapable of weighing them and making an efficient decision." [Ref. 8:108].

The purpose of this study is threefold. First, to identify those factors, relevant in the military context, of life evaluation that can be quantified; second, to develop a model for estimating the cost of a soldier killed in action (KIA); and third, to show by examples the upper and lower cost estimates of a KIA. The emphasis throughout the study will be on developing a systematic procedure, which combined with existing or derived cost data, will provide military decision makers with a meaningful value of a KIA.

The approach to this problem of determining the cost of a KIA requires, as do most complex problems, certain assumptions. For the purpose of this study two underlying assumptions are made. First, that only limited type wars such as Korea and Vietnam will be considered. Even though the problem would still exist in an all out conflict, it would by comparison become less important for decision making. The second assumption is that there exists a pipeline of trained personnel available

for immediate replacement of combat losses. In addition it is assumed that the pipeline will be kept at some specified level by acquiring new personnel either through the draft or by volunteers. Other assumptions will be identified with the particular part of the problem to which they apply.

The study is divided into seven sections; the first being the introduction. Section II outlines certain considerations of life evaluation in general and presents a detailed discussion on evaluating the loss to society of a KIA. The factors constituting the loss to the military of a KIA are identified and discussed in Section III. In Section IV the results from Sections II and III are formed into a model for estimating the total cost of a KIA and in Section V the model is put to use to determine the upper and lower cost estimates of a KIA. A limited sensitivity analysis is made in Section VI. Section VII contains the summary and conclusions.

II. CONSIDERATIONS IN LIFE VALUATION AND LOSS TO SOCIETY

A KIA results in two losses, a loss to the military and a loss to society, and the true cost cannot be determined unless both of these losses are evaluated. This section presents certain considerations that pertain to life valuation in general and then discusses the loss to society of a KIA and its evaluation.

Life value consists of two all-inclusive aspects, ethical and utilitarian. There is no logical or meaningful way to reduce the ethical aspect to quantitative terms. In an ethical sense, even for an a posteriori valuation, no one can say that one human life is worth more than another or that John Doe is worth 1.3 Bill Smith's. Ethically, life value is intangible and incapable of being measured. For this reason, no attempt will be made to evaluate it or to incorporate it in anyway in determining the cost of a KIA. It should be made clear that although the remainder of this study concerns only the utilitarian aspects, the ethical part of the cost is not unimportant. It only means that any ethical value must rest on the subjective preferences of the decision maker.

The utilitarian aspect consists of two components, economic and emotional. Economic is defined as the monetary support, contribution, and service of an individual to his family and to society as a whole. Emotional is defined as the effect an individual has on the morale and well being of his family and society.

A. EMOTIONAL COMPONENT

Attempts have and are being made to identify and evaluate emotional factors. For example, the American legal system is continually faced with the problem of determing a just monetary compensation for "emotional loss", such factors as mental anguish, loss of companionship, loss of comfort, etc.,. It suffices to say that these attempts by the courts have not resulted in any uniform or consistent values, even for similar cases under almost identical circumstances. However, these attempts by the courts do reveal two very important facts. First, the emotional component is recognized as a distinct, separate, and necessary component in the evaluation of human life. Secondly, the factors that comprise the emotional component are not well defined and at best are very difficult to evaluate. There is no one accepted way of evaluating mental anguish, loss of companionship, loss of comfort, or loss of consortium. The courts, where these factors are considered on an after the fact basis, cannot agree as to what constitutes emotional loss, under what circumstances it should be allowed, or how much compensation should be granted.

How then should the emotional and ethical components be treated? They must be included or the end result will be misleading. There are two possible alternatives. One alternative would be to assign a constant value or a range of values based on what could be called a "typical KIA", that is, one who best describes the average KIA as to age, family ties, number of dependents, etc., The value or values assigned would

be based on the average or range of values awarded by the courts for emotional loss under similar circumstances. There is one major disadvantage, other than requiring a great deal of research, in using this alternative. By placing a dollar value on the emotional and ethical components, the true value of these intangibles is not conveyed to the decision maker. He would not experience their full impact and his decision might well be different if he were forced to consider the cost of a KIA in both an economic or dollar sense and an emotional and ethical sense.

This leads to the second alternative, that being assign no dollar value to the emotional and ethical components, but rather present the decision maker with the economic dollar cost of a project or system's expected KIA's plus the number and breakdown of the expected KIA's. In those cases requiring close scrutiny and detailed comparison, it would be left to the decision maker as to what value, if any, he wants to assign to the emotional and ethical components. Such an evaluation, by necessity, would be based on the experience, intuition, judgment, and personal feelings of the decision maker; however, this alternative would force the decision maker to consider these losses carefully. This is the approach that will be used in this study. The intangible components will not be assigned a dollar value, but with the understanding that the decision maker will be provided the number and breakdown of the expected KIA's.

B. ECONOMIC COMPONENT

How one can evaluate the economic component is the next question to be considered. Since there is no slave market, the price system does not include the relevant price, and therefore, some other means must be devised to determine the economic value of a human life. Several possibilities have been suggested. As mentioned previously, the American legal system is faced with this problem and the results from its efforts will be the first possibility to be discussed. The courts are perhaps the only place in society where such a deliberate and realistic attempt is made to establish the true economic value of a human life. Data obtained from cases on file would, when properly analyzed, provide an estimate of the economic component or at least a value in the legal sense. There are certain drawbacks in using this approach. The right to compensation for wrongful death is not a natural right under common law, but is provided through the legislative powers of the states. There are considerable differences not only in the amounts awarded, but also as to what constitutes "loss". In almost every state the economic factors constituting loss are fairly standard, but the values ascribed to them vary considerably. Some states include awards for emotional loss thus making it difficult to distinguish between economic and emotional awards. Some states have established minimum and maximum amounts that can be granted while others have no limits. For these reasons, this approach is not considered feasible for determining the economic value of a human life.

A second possibility makes use of the data associated with various safety and life saving programs. The ratio between changes in expenditures for safety purposes and the resulting changes in the number of lives saved as a result of the expenditures implies the value of a human life. An example is the highway safety program. There is a significant loss of life associated specifically with highway accidents and there is a significant expenditure of funds aimed specifically at reducing this loss of life. The presence of these two factors imply the existence of trade off considerations between money spent and lives saved. The methodology is simple and straightforward and there exists an abundance of data; however, there are certain difficulties. The major one being the interpretation of the available data. Both private and government agencies are involved in highway safety programs and true expenditures are difficult to extract. Federal and state funds can be considered as true safety expenditures and these figures can be obtained from their respective budgets. This is not necessarily the case involving private expenditures. A large portion of the funds shown as safety expenditures actually go toward the creation of a good public image and advertising. An additional difficulty associated with this approach is that of selecting a realistic value. Suppose the number of deaths could be reduced by 20 percent at a cost of x dollars per life saved, but to reduce the number of deaths by 25 percent would require 4X dollars per life saved. Which of the two values is the more representative? The estimates obtained from this approach would be better used in reallocating funds from one life saving

program or project to another rather than as an indication of the value of a human life. For these reasons, this approach is not considered feasible.

The final possibility is what may be termed the income approach. It assumes that the economic value of a human life is equivalent to the present value of an individual's expected lifetime income. This approach is intuitively appealing for if one considers the definition given previously of the economic component, an individual's income is the monetary support he provides for his family. The monetary support to society by an individual can be considered in most cases to be the amount of taxes he pays and the amount of his monetary contributions, both of which are directly related to the amount of income he receives. Of course this is not necessarily true when the nonmonetary service of an individual to his family and society is measured. This type service provided by many individuals has no correlation whatever with the amount of income received. For example, consider the two extremes, the service provided by a social worker with a relatively low income and the disservice provided by a racketeer with a high income. It must be kept in mind that these are extreme cases and their overall effect will be negligible when averaged with the larger population segment. It is felt that the income approach will provide a reasonable evaluation of the economic component and when properly structured will take into account not only an individual's age, education, and geographical area, all of which are relevant factors; but in addition will consider the effects of economic growth.

A method for estimating the expected lifetime income of an individual has been suggested by Herman P. Miller [Ref. 12], research economist with the U. S. Bureau of the Census. Miller's method, with certain modifications, is to divide the adult male population into groups and subgroups as shown.

Geographical Area	Age Group	Education
North and Western United States	18-24	Elementary
	25-34	High School
Southern United States	35-44	College
	45-54	
	55-65	

Then, by using cross-section surveys, the expected annual income can be ascertained for each combination of subgroups, e.g., all the males in the Southern United States in age group 35-44 with a high school education. The present value of the expected lifetime income can be computed as:

$$PV_N = \sum_{J=N}^{45} Y_J P_J (1+X)\ (1+R)^{N-J} + \sum_{J=46}^{65} Y_J P_J (1+W)(1+R)^{N-J}$$

where: PV_N is the present value of the total expected lifetime income at age N.

Y_J is the expected annual income at age J.

X is the economic growth factor associated with age groups 18-45.

W is the economic growth factor associated with age groups 46-65.

P_J is the probability of surviving an additional year at age J.

R is the discount rate.

N is the starting age at which the expected lifetime income is to be computed.

It is assumed for the above model that the average income for the entire age subgroup applies to each of the single years of age within the sub-group and that income expected past the age of 65 is not significant.

The income approach has many unique advantages that make it ideal for use in estimating the cost to society of a KIA. The distribution of KIA's include individuals of all ages, varying amounts of education, and from all geographical areas. The income approach takes all of these factors into consideration. In addition, the income approach draws its required inputs, that is the cross-section survey data, from existing and up to date data maintained by the U. S. Census Bureau thereby eliminating the need for data collection, reduction, and analysis by the military. For these reasons, the income approach was selected for estimating the economic loss to society of a KIA.

C. SUMMARY

Diagrammatically, Figure 1 summarizes this section. The value of a human life consists of two aspects, ethical and utilitarian, the latter composed of an economic and emotional component. The human life, when viewed as a KIA, results in a loss to both the military and to society as a whole. The ethical and emotional components, although not capable of being evaluated in monetary terms, cannot be ignored. The values ascribed to these intangible losses must be left to the subjective preferences of the decision maker. The income approach offers the best method for evaluating the economic loss to society and this loss is

equated to the lifetime income a KIA would expect to receive had he lived. The loss to the military is discussed in the next section.

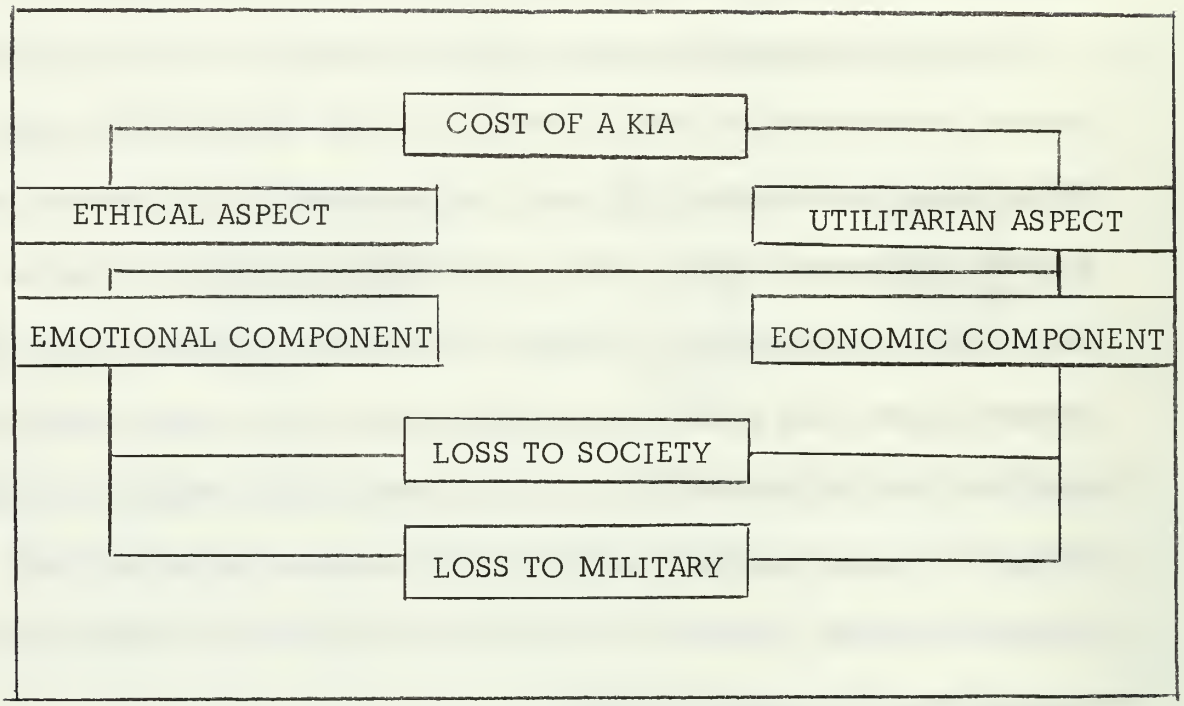

Figure 1. Cost of KIA

III. LOSS TO THE MILITARY

As mentioned previously, a KIA results in a loss to both the military and to society. In Section II the loss to Society was discussed and in this section the economic and emotional losses to the military will be covered.

A. EMOTIONAL

The emotional loss to the military is very similar to the emotional loss to society in that both are defined as an effect on morale and well being, the family being the recipient in the case of society and the military unit in the case of the military. Closely akin to this emotional loss suffered by the military, and for the purpose of this study it will be included as part of the emotional loss, is the loss of experience associated with a KIA. Both the effect on an unit's morale and the loss of experience are very much dependent on the number and type (MOS, grade, length of service) of KIA's. The overall loss related with these two factors cannot be disregarded nor can they be evaluated in terms of dollar costs. As was the case in handling the emotional loss to society, the decision maker must be presented with the number and breakdown of the expected KIA's and in his own mind must evaluate the emotional loss, not only to society but also to the military.

B. ECONOMIC

Purely from an economic view, a soldier is no different from any other military resource, the loss of which can be evaluated in terms of

how much replacement will cost. This will be the approach used to determine the economic loss to the military of a KIA; however, there are minor deviations from the current Department of Defense policy for producing such costs. Replacement costs can be divided into three broad categories; procurement, training, and operating costs. Each of these categories must be discussed in terms of officer and enlisted costs, made necessary by the lack of common factors within each category and the wide variance of cost.

Enlisted procurement costs are pre-service costs incurred by the military from the time of first contact of a prospect up to the time of arrival at his first duty station. They include the dollar cost per enlistee or draftee for recruiting, inducting, processing, initial issue of clothing, and accession travel to the first duty station. Included in the cost of recruiting are pay and allowances of personnel involved in the direct or indirect support of the recuiting effort and expenses attributable to recruiting such as travel of recruiters and applicants, advertising, vehicle operating and maintenance costs, rent and utilities for leased real property, and vehicle amortization. In the case of officer procurement, the costs are those incurred in the production of an officer from one of the three main sources of commission; USMA, ROTC or OCS. Also included are the costs of the initial clothing and uniform allowance and accession travel to the first duty station.

Training costs are computed as the per capita cost of basic training and specialized (MOS) training in the case of enlisted men and in the

case of officer personnel as the per capita cost of branch training and any specialized training such as flight, ranger, airborne, etc. Training costs cover only those costs directly applicable to the operation and maintenance of the schools to include the pay and allowances of instructor personnel, training aids, supplies, maintenance of equipment, and administrative costs. Not included are pay and allowances for the students, capital costs of real property, or overhead and support costs of the installation.

Operating costs include all pay and allowances received by an individual other than those included as pre-service costs. All future transportation costs, to include dependents, after arrival at the first duty station are classified as operating costs. Listed as pay and allowances are base pay, flight pay, incentive pay, hostile fire pay, proficiency pay in the case of enlisted personnel, quarters allowance, family separation allowance, subsistence, social security and insurance contributions by the government, and clothing maintenance allowance.

The economic loss to the military is the sum of the procurement, training, and operating costs. Before concluding this section, mention should be made of two items not previously discussed. One is the death benefits paid by the government to the family or estate of a KIA. These benefits include six months gratuity pay, dependency and indemnity compensation, social security and veteran benefits. The question arises as to whether or not these benefits should be included as part of the economic loss to the military. The answer is that they should not. These benefits are in essence the same as transfer payments and if they are

included as a loss to the military then they must also be included as a gain to society since they represent income to the family or estate of a KIA that would not normally be received. The other item is the savings resulting in the government not having to pay post-service benefits akin to the release of an individual from active duty. In particular, the savings resulting from not having to provide benefits under the GI Bill for education. This so called saving is not included since it was assumed that every KIA would be replaced and therefore no saving would accrue in the long run.

In summary, the loss to the military of a KIA, as in the loss to society, consists of an economic and emotional component. Both of these components must be considered to produce a reasonable estimate. The emotional component, defined as the effect on the unit's morale and well being and the loss of experience, cannot be evaluated in dollar costs; however, the decision maker must be made aware of its existence and make an evaluation based on his judgment. The economic loss to the military can be determined by computing the costs associated with replacement, those being procurement, training, and operating costs. Costs and/or savings connected with death benefits and post-service veteran benefits are not applicable to the overall cost of a KIA. Combining all the relevant cost factors, both to the military and society, into a cost model is the subject of the next section.

IV. FORMULATION OF THE COST MODEL

The relevant cost factors were identified in the previous two sections. The purpose of this section is to take these cost factors and form them into a model that will provide a realistic cost estimate of a KIA. Again it must be kept in mind that only the economic cost will be estimated by the model.

A. LOSS TO SOCIETY

The economic loss to society was developed in Section II as the expected lifetime income an individual would receive and is computed as follows:

$$PV_N = (1+X) \sum_{J=N}^{45} Y_J P_J (1+R)^{N-J} + (1+W) \sum_{J=46}^{65} Y_J P_J (1+R)^{N-J} \quad (4.1)$$

where: PV_N is the present value of the total expected lifetime income at age N.

Y_J is the expected annual income at age J.

X, W are the economic growth factors associated with age groups 18-45 and 46-65 respectively.

P_J is the probability of surviving an additional year at age J.

R is the discount rate.

N is the age at time of death.

B. LOSS TO THE MILITARY

The economic loss to the military is composed of three cost categories; procurement costs, training costs, and operating costs. A

detailed breakdown of the cost factors for each category and their formulation follow.

1. Procurement Costs

The equations for determing procurement costs are:

$$PC = CC + CA + AT \quad \text{(Officer)} \tag{4.2}$$

$$PC = RC + IP + CA + AT \quad \text{(Enlisted)} \tag{4.3}$$

where: PC is the total procurement cost.
CC is the officer commissioning cost.
CA is the initial clothing allowance.
AT is the accession travel cost to the first duty station.
RC is the recruiting or selective service cost.
IP is the induction processing cost.

2. Training Costs

The training cost equations are:

$$TG = BS + ST \quad \text{(Officer)} \tag{4.4}$$

$$TG = BT + ST \quad \text{(Enlisted} \tag{4.5}$$

where: TG is the total training cost.
BS is the cost of officer branch school training.
ST is the cost of specialized or MOS training.
BT is the cost of enlisted basic training.

3. Operating Costs

Operating cost equations are developed as:

$$OC=LS(BP+S+QA+SS+HD+FP+CB+FS+TR) \quad \text{(Officer)} \tag{4.6}$$

$$OC=LS(BP+S+QA+CM+SS+PP+HD+FP+CB+FS+TR) \quad \text{(Enlisted)} \tag{4.7}$$

where: OC is the total operating cost.

LS is the length of service.

BP is base pay.

S is subsistence allowance.

QA is quarters allowance.

SS is the social security contribution by the military.

HD is hazardous duty pay.

FP is flight pay.

CB is combat pay.

FS is family separation allowance.

TR is travel cost after arrival at the first duty station.

CM is clothing maintenance allowance.

PP is proficiency pay.

C. OVERALL COST MODEL

Combining both military and society losses, the overall cost model now becomes:

$$TC = PV + PC + TG + OC \tag{4.8}$$

where TC represents the total economic cost of a KIA. The overall cost model can be subdivided into two models, one for officer costs and one for enlisted costs. Formulation of these two models follow.

1. Officer Cost Model

$$TC = (1+X)\sum_{J=N}^{45} Y_J P_J (1+R)^{N-J} + (1+W)\sum_{J=46}^{65} Y_J P_J (1+R)^{N-J} +$$

$$CC + CA + AT + BS + ST + LS(BP + S + QA + SS +$$

$$HD + FP + CM + FS + TR) \tag{4.9}$$

2. Enlisted Cost Model

$$TC = (1+X) \sum_{J=N}^{45} Y_J P_J (1+R)^{N-J} + (1+W) \sum_{J=46}^{65} Y_J P_J (1+R)^{N-J} +$$

$$RC + IP + CA + AT + BT + ST + LS(BP + S + QA + CM +$$

$$SS + PP + HD + FP + CB + FS + TR) \qquad (4.10)$$

It should be pointed out that not necessarily all the elements of the above two models will apply in all cases. For example, not all officers and enlisted men receive flight pay nor do all receive hazardous duty pay. The procedures for determining which elements are applicable and their values is covered in Section V.

It is again emphasized that the two models, equations (4.9) and (4.10), formulated in this section will reflect only the estimated economic cost of a KIA. They do not include any value for the intangible losses suffered by society and the military. This determination rests with the decision maker.

V. COMPUTATIONAL PROCEDURES

The purpose of this section is to establish the procedures for determining values for each of the model elements. In many cases, depending on the circumstances, the value of an element may take on one of several values. For these elements a range of values have been established. The data used for assigning the different element values came from many sources. One major source was the in-house reports and studies conducted by Department of Defense agencies. Included also are contract personnel cost studies developed by various civilian firms such as the Research Analysis Corporation and the Rand Corporation. Other data sources included the U. S. Bureau of the Census, Veteran's Administration, Military Pay and Entitlements Manual, and Vietnam casualty reports. Each data source used to develop a value for a specific model element has been identified.

The first elements evaluated were those associated with the economic loss to society or the expected lifetime income, PV. Recall that this loss was given as:

$$PV_N = (1+X) \sum_{J=N}^{45} Y_J P_J (1+R)^{N-J} + (1+W) \sum_{J=46}^{65} Y_J P_J (1+R)^{N-J}$$

Values for the element P_J, the probability of surviving an additional year at age J, were taken directly from the mortality tables developed by the Actuarial Society of America [Ref. 22:583]. These values are shown in Table I. The elements X and W, the economic growth factors associated with age groups 18-45 and 46-65 respectively, were computed by Miller

[Ref. 12] using unpublished data from the U. S. Bureau of the Census. Table II summarizes Miller's findings. The element R, the discount rate, was selected to be 10%. This selection adheres to the current Department of Defense policy as outlined in DOD Instruction 7041.3 [Ref. 6].

TABLE I. MORTALITY TABLE

Age	P	Age	P	Age	P	Age	P	Age	P
18	.99831	28	.99797	38	.99699	48	.99305	58	.98400
19	.99826	29	.99792	39	.99675	49	.99240	59	.98241
20	.99821	30	.99787	40	.99647	50	.99168	60	.98066
21	.99817	32	.99781	41	.99616	51	.99089	61	.97876
22	.99814	32	.99775	42	.99583	52	.99004	62	.97669
23	.99811	33	.99768	43	.99547	53	.98911	63	.97443
24	.99809	34	.99760	44	.99508	54	.98810	64	.97196
25	.99807	35	.99749	45	.99465	55	.98700	65	.96800
26	.99804	36	.99736	46	.99417	56	.98679		
27	.99801	37	.99720	47	.99364	57	.98546		

TABLE II. ECONOMIC GROWTH FACTORS (%)

	X			W		
Education Level	Elem	HS	Col	Elem	HS	Col
North & Western U. S.	3.4	4.1	5.5	2.7	2.2	1.9
Southern U. S.	3.6	3.0	4.4	2.5	2.0	1.5
Average Entire U. S.	3.4	3.9	5.1	2.5	2.1	1.8

The expected annual income, as compiled by Miller [Ref. 12] for the year 1959, was used as a basis for projecting the expected annual income for 1970. To update Miller's findings, increases from two factors over this eleven year span had to be considered. First was the increase in income

associated with increased prices. A total increase of 25% was assumed. This closely corresponds to the U. S. Department of Labor's Consumer Price Index of 100.0 for the 1957-59 period and the present (June 1969) price index of about 125.0. The second factor was the increase in income due to changes in productivity. The United States economy has shown an annual increase of from 2.6 to 4.6 percent during the period 1959 through 1967 [Ref. 23:315]. For the purpose of this study a constant growth rate of 3 percent was assumed for the period 1959-70. Considering both the increase in prices and productivity, an updating factor can be computed and when applied to Miller's 1959 income data will project the estimated income for 1970. The updating factor was computed to be $(1.25)(1.03)^{11} = 1.73$. For example, an annual income of $3,000 in 1959 would be estimated to be ($3,000)(1.73) = $5,190 in 1970. The results of this updating are shown in Table III.

TABLE III. PROJECTED AVERAGE ANNUAL INCOME FOR 1970 ($)

Region	Educational Level	Age Groups				
		18-24	25-34	35-44	45-54	55-65
North & Western U. S.	Elem	4800	7950	8850	9000	8800
	HS	5550	9750	11500	11900	12000
	Col	6350	12250	17400	20200	20400
Southern U. S.	Elem	3460	6130	7050	7200	7050
	HS	4670	8450	10300	10900	11250
	Col	6160	11550	16000	18000	18900

The element N, the expected age of the KIA or the starting age at which the expected lifetime income is to be computed, was selected to be 24 in the

case of officer personnel and 20 in the case of enlisted personnel. This selection was based on unpublished data collected on U. S. casualties in Sourtheast Asia through September 1968 and made available by Vietnam Wound Data Collection and Evaluation Team, Edgewood Arsenal. Portions of these data are reproduced in Tables IV through VII.

TABLE IV. HOSTILE DEATHS BY AGE

Age	Number	Age	Number	Age	Number
17	7	25	725	33	144
18	674	26	512	34	157
19	2186	27	296	35	138
20	4429	28	225	36	141
21	2878	29	237	37	124
22	1518	30	184	38	95
23	1293	31	195	39	65
24	997	32	154	40& over	166

TABLE V. HOSTILE DEATHS BY GRADE

Officer			Enlisted	
Pay Grade	Rank	Total	Pay Grade	Total
01	2Lt	384	E1	41
02	1Lt	579	E2	172
03	Cpt	397	E3	6946
04	Maj	93	E4	4930
05	LTC	31	E5	2184
06 & above	Col & above	2	E6	1061
			E7	439
			E8, E9	82

TABLE VI. HOSTILE DEATHS BY LENGTH OF SERVICE

Length of Service for Pay Purposes	Total
Under 1 Year	6057
Under 2 Years	6129
Over 2 Years	1495
Over 3 Years	432
Over 4 Years	760
Over 5 Years	592
Over 8 Years	398
Over 10 Years	370
Over 12-20 Years	1307

TABLE VII. HOSTILE DEATHS BY REGION

Region	Total
North & Western U. S.	11,096
Southern U. S.	6,223
Other	221

The final elements evaluated were those associated with the economic loss to the military. The loss to the military was divided into three cost areas; procurement, training, and operating costs and each area further divided as to costs for officer and enlisted personnel. Procurement costs were formulated in equations (4.2) and (4.3) as:

$$PC = CC + CA + AT \qquad \text{(Officer)}$$

$$PC = RC + IP + CA + AT \qquad \text{(Enlisted)}$$

Cost data for each of these elements were taken from technical papers prepared by Sorkin and Wax of the Research Analysis Corporation [Ref.18]

and by Fechter of the Institute for Defense Analyses [Ref. 9]. Values, reflecting total cost for each element, are shown in Table VIII.

The training cost elements, as shown in equations (4.4) and (4.5) are:

$$TG = BS + ST \qquad \text{(Officer)}$$

$$TG = BT + ST \qquad \text{(Enlisted)}$$

These elemements were the most difficult to assign values. The Army Service Schools do not develop the training cost of an individual as a regular procedure. To obtain such costs requires a special request from CONARC to a specific school and then, only after many man-hours of effort, can the results be obtained. The difficulty is further compounded because the cost elements recorded by the Service Schools are not consistent from school to school. For example, on those installations where the school is the major activity, many of the activities not associated with training are recorded as training costs; whereas a similar school on a different installation where the school is not the major activity, many of the legitimate training costs are recorded under installation activities. Nevertheless, an attempt was made to assign reasonable values to each of the cost elements, realizing that the assigned values would be representative values only and would not necessarily hold for all the Service Schools. In addition, only those MOS's which are more likely to become KIA's were considered. The values assigned are shown in Table IX with the data source for each cost element.

The operating costs, as given by equations (4.6) and (4.7), for the most part are taken from the current pay and allowances tables. The length of service for pay purposes was taken to be 18 months for an enlisted man and 24 months for an officer. The operating costs reflect the total operating costs for these periods. The cost factors and their associated values are shown in Table X.

TABLE VIII. PROCUREMENT COSTS ($)

Officer Procurement					Enlisted Procurement			
Source	Percent of Total Accessions	Cost Factors			Source	Cost Factors		
		CC	CA	AT		(RC+IP)	CA	AT
USMA	2.2	45,650	0	303	Enlistee	147	165	73
ROTC	43.1	3,950	300	303	Draftee	76	165	73
OCS	25.0	9,336	250	303				

TABLE IX. TRAINING COSTS ($)

Officer		Enlisted	
Cost Factor	Cost	Cost Factor	Cost
BS[Ref. 18]	650	BT[Ref. 18]	500
ST[Ref. 19]		ST[Ref. 1]	
Flight Tng	20,000	Lt Wpns Inf	695
		Wheel Mech	1161
		Intel Spec	1265
		Hel Repair	1585

TABLE X. OPERATING COSTS ($/TIME PERIOD)

Cost Factors	Officer	Enlisted
BP	Varies as to pay grade and length of service.	Varies as to pay grade and length of service
S	$47.88 per month	Avg of $440 per year
QA	Varies as to pay grade and marital status.	Varies as to pay grade and number of dependents
SS[Ref. 18]	Avg of $162 per year.	Avg of $77 per year
HD	$110 per month	$55 per month
FP[Ref. 18]	Avg of $2064 per year.	Avg of $1082 per year.
CB	$65 per month	$65 per month
FS	$30 per month	$30 per month
PP[Ref. 18]	N/A	Avg of $564 per year
CM[Ref. 18]	N/A	Avg of $65 per year
TR[Ref. 18]	Avg of $3000 per year.	Avg of $482 per year.

The use of the model is illustrated by three examples. The first example estimates the economic cost of what may be called the "typical" or average KIA. The second and third examples estimate the lower and upper cost estimates of a KIA. All three examples have been computed for both an officer and enlisted KIA.

A. AVERAGE COST ESTIMATE

Referring to Tables IV, V, VI, VII, and VIII; the average officer KIA could be described as a First Lieutenant with two years service, commissioned through ROTC, 24 years old, married, and from the North or Western United States. The average enlisted KIA could be described as a PFC (E3), light weapons infantry MOS, with under two years service, 20 years old with a high school education, single, and from the North or Western United States. The total economic cost was computed using

equations (4.9) and (4.10). A detailed listing of the model elements and their computed values are given in the following fact sheets.

Fact Sheet: Average Officer KIA

Sym	Cost Element	Value	Computation
PV	Expected Lifetime Income	$155,710	$PV=(1+X)\sum_{J=N}^{45} Y_J P_J (1+R)^{N-J} +$ $(1+W)\sum_{J=46}^{65} Y_J P_J (1+R)^{N-J}$ $=(1.055)\sum_{J=24}^{45} Y_J P_J (1.1)^{24-J} +$ $(1.019)\sum_{J=46}^{65} Y_J P_J (1.1)^{24-J}$ $= \underline{\$155,710}$
X	Growth Rate	5.5%	
W	Growth Rate	1.9%	
R	Discount Rate	10%	
Y_J	Avg Annual Income at age J	Table III	
P_J	Prob of Surviving to J+1	Table I	
N	Age of KIA	24	
PC	Procurement Costs	$ 4,553	PC=CC + CA + AT = 3,950 + 300 + 303 = $\underline{\$4,553}$
CC	ROTC Cost	$ 3,950	
CA	Cloth Allow	300	
AT	Accession Tvl	303	
TG	Training Costs	$ 650	TG=BS + ST = 650 + 0 = $\underline{\$650}$
BS	Branch School	$ 650	
ST	Spec Tng	0	

OC	Operating Costs	$20,968	OC=LS(BP+S+QA+SS+HD+FP+CB +FS+TR) =2(4827+(12)(47.88)+1350+ 162+0+0+(6)(65)+(6)(30)+ 3000) =$20,968
LS	Length of Svr	2 years	
BP	Base Pay	$4827/yr	
S	Subsistence	$47.88/mo	
QA	Quarters Allow	$1350/yr	
SS	Soc Sec	$162/yr	
HD	Hazard Dy Pay	$0	
FP	Flight Pay	$0	
CB	Combat Pay	$65/mo	
FS	Family Sep	$30/mo	
TR	Travel Cost	$3000/yr	
TC	Total Cost	$181,881	TC=PV + PC + TG + OC = 155,710 + 4,553 + 650 + 20,968 = $181,881

Fact Sheet: Average Enlisted KIA

Sym	Cost Element	Value	Computation
PV	Expected Lifetime Income	$ 96,506	$PV=(1+X)\sum_{J=N}^{45} Y_J P_J (1+R)^{N-J} +$ $(1+W)\sum_{J=46}^{65} Y_J P_J (1+R)^{N-J}$ $=(1.041)\sum_{J=20}^{45} Y_J P_J (1.1)^{20-J} +$ $(1.022)\sum_{J=46}^{65} Y_J P_J (1.1)^{20-J}$ $= \underline{\$96,506}$
X	Growth Rate	4.1%	
W	Growth Rate	2.2%	
R	Discount Rate	10%	
Y_J	Avg Annual Income at age J	Table III	
P_J	Prob of Surviving to J+1	Table I	
N	Age of KIA	20	
PC	Procurement Costs	$ 385	PC=(RC + IP) + CA + AT = 147 + 165 + 73 = $385
RC	Recruiting Cost	$ 147	
IP	Processing Cost		
CA	Cloth Allow	$ 165	
AT	Accession Tvl	$ 73	

TG	Training Costs	$ 1,195	TG=BT + ST = 500 + 695 = $1,195
BT	Basic Training	$ 500	
ST	MOS Training	$ 695	
OC	Operating Costs	$ 6,858	OC=LS(BP+S+QA+CM+SS+PP+HD+FP+CB+FS+TR) =1.5(1704+440+720+65+77+564+0+0+520+0+482) = $6,858
BP	Base Pay	$1704/yr	
S	Subsistence	$440/yr	
QA	Quarters Allow	$720/yr	
CM	Cloth Maint	$65/yr	
SS	Soc Sec	$77/yr	
PP	Proficiency Pay	$564/yr	
HD	Hazard Dy Pay	$0	
FP	Flight Pay	$0	
CB	Combat Pay	$65/mo	
FS	Family Sep	$0	
TR	Travel Cost	$482/yr	
LS	Length of Svr	18 mo	
TC	Total Cost	$104,944	TC=PV + PC + TG + OC = 96,506 + 385 + 1,195 + 6,858 = $104,944

B. LOWER BOUND COST ESTIMATE

To establish the lower bound for the cost estimate of a KIA, it was necessary to select values for the cost elements in such a way that the cost would be a minimum and that there would be no artificiality introduced. For example, the minimum cost to society for an officer KIA is obtained by using a high school level of education in computing PV. In determining the cost to the military, the minimum procurement cost is associated with accession through ROTC; however, this contradicts the level of education. Therefore, to prevent contradiction and still arrive at

the minimum cost, accession through OCS must be assumed. Certain of the model elements were not changed from what was developed in the first example; those being age of the KIA, length of service, the economic growth factors, and the discount rate. The model's sensitivity to changes in these elements will be discussed later. The lower bound for the cost estimate was found by first minimizing the loss to society as this component accounted for the majority of the total cost. In both cases, officer and enlisted, this meant using the minimum educational level available and the geographical region that would result in the smallest expected lifetime income. Once this loss was established, the loss to the military was minimized by selecting input values associated with the last cost for procurement, training, and operating. The computational procedures and equations were the same as used in the first example. A breakdown of the lower bound cost estimate is as follows:

Lower Bound Cost Estimate

			Officer	Enlisted
Cost to Society			$ 97,437	$ 59,849
Cost to Military	Officer	Enlisted		
Procurement	$ 9,889	$ 314		
Training	0	1,195		
Operating	17,012	6,012		
			26,901	7,521
Minimum Total Cost			$124,338	$ 67,370

C. UPPER BOUND COST ESTIMATE

To establish the upper bound for the cost estimate, the same procedures were used as in the second example with the obvious exception that

maximum values of the cost elements were used rather than the minimum. Again no changes were made in the expected age of a KIA, his length of service, the economic growth factors, or the discount rate from the first example. The economic loss to society was first maximized by selecting the highest level of education and geographical region that would result in the largest expected lifetime income. The cost to the military was then maximized to the extent possible by selecting values for the various model elements that would produce the greatest cost. In the case of an officer KIA, for example, it was assumed that he was commissioned through USMA, that he had received flight training, and that he was on flight status at time of death. The same computational procedures and equations were used as in the previous two examples. The results are as follows:

Upper Bound Cost Estimate

			Officer	Enlisted
Cost to Society			$155,710	$141,512
Cost to Military	Officer	Enlisted		
Procurement	$45,953	$ 385		
Training	20,650	2,085		
Operating	25,096	9,651		
			91,699	112,121
Maximum Total Cost.			$247,409	$153,633

These three examples reveal what may be called the "economic cost of an average KIA" and the associated upper and lower cost bounds. In the next section the model's sensitivity to changes in the discount rate, the economic growth factors, and the age of the KIA will be tested. Again

it is emphasized that the results of these three examples do not reveal the true cost of a KIA. The ethical aspect along with the emotional loss suffered by society and the military must be considered before a true cost can be determined.

VI. SENSITIVITY ANALYSIS

The previous sections were devoted to the identification and valuation of the relevant cost factors and the formulation of these factors into a cost model. An estimated cost of a KIA was determined, but the cost was based on the assumption that certain of the model elements would remain constant. These elements were the discount rate, the economic growth factors, and the age of the KIA. The purpose of this section is to determine what effects, if any, changes in these elements will have on the total KIA cost.

Before proceeding, the differences in the average, lower, and upper cost estimates should be examined. Referring to the previous section, it was found that the cost estimates for an officer KIA varied from a low of about $125,000 to a high of about $250,000 with the average being about $180,000. Component wise, the loss to society or the present value of the expected lifetime income accounted for the majority of the total cost in all three estimates. In fact, it accounted for 86% of the total cost in the average estimate, 78% in the lower estimate, and 63% of the upper estimate. The loss to the military remained relatively constant in all three estimates indicating that the wide variance of costs was due almost entirely to changes in the loss to society. There is one exception. In the case of the upper estimate, flight training and accession through USMA accounted for about $65,000 or 26% of the total upper bound estimate. The cost to society of an officer KIA ranged from about

$97,000 for the lower estimate to about $155,000 for the average and upper estimates. Age of the KIA and the discounte rate remained the same indicating that geographical region and level of education have a marked influence on the total social cost. A 60% increase in the present value of a lifetime income can be experienced from moving from a high school level of education in the Southern United States to that of a college level in the north or Western United States. Essentially, the same effects found in the officer case hold for the enlisted case. The total cost for the enlisted KIA ranged from a low of $67,000 to a high of $153,000 with the average being $105,000. As in the officer case, the loss to the military remained almost constant for all three estimates with the loss to society accounting for the majority of the total cost and almost all of the variance betwwen the estimates. Clearly, the loss to society is the dominant cost category and it is primarily dependent upon the level of education and the geographical region.

To study the effects of changes in the discount rate, values of 5%, 7.5%, and 12% were compared to the basic rate of 10%, holding all other model elements constant. As was expected, the lower the discount rate the higher the total cost. Specific results are shown in Table XI.

TABLE XI. EFFECTS OF CHANGES IN THE DISCOUNT RATE

Discount Rate	Total Cost		Percentage Change	
	Officer	Enlisted	Officer	Enlisted
10% (Base)	$181,881	$104,944	-	-
12%	$128,980	$ 79,495	-29%	-25%
7.5%	$206,482	$129,120	+13%	+23%
5%	$292,098	$185,161	+60%	+76%

The effects of economic growth were examined by computing the loss to society both with and without the assumed growth rates. The loss to society was only increased a total of $7,331 in the case of an officer KIA and $3,631 in the case of an enlisted KIA when the economic growth rates were used. These increases are insignificant when compared to the total cost of approximately $181,000 for an officer KIA and approximately $104,000 for an enlisted KIA. This implies that any reasonable economic growth rate up to six or seven percent could be omitted from the computations without significantly affecting the end results.

The last parameter tested was the age of the KIA. It is obvious that the loss to the military increases as the age of the KIA increases. Length of service and base pay increase as age increases, resulting in larger operating costs. The effect of age changes on the cost to society, which is the dominant cost, is not so apparent. The loss to society was computed for ages 18 through 35. No values of N greater than 35 were checked since 97% of the casualties occur in the age range 18-35. At first glance it would appear that the loss to society would decrease as the age of the KIA increased; however, with the age range and discount rate used (R=10%), just the opposite occurred. That is, as age increased, the loss to society also increased. For example, in the officer case the loss to society increased from a value of $120,084 at age 18 to a value of $199,185 at age 35, with the greatest jump from age 24 to age 25. Similarly, in the enlisted case, the social loss increased from $90,758 at age 18 to $125,051 at age 35. This result, when combined with the

increase to the military cost due to an increase in age, indicates the cost model is sensitive to changes in the age of the KIA.

In summary, the cost model developed is sensitive to changes in all its elements with the exception of the economic growth factors. The loss to society is the dominant cost category and it varies according to the selection of geographical region and level of education as well as the discount rate and age of the KIA. The loss to the military remains fairly constant; varying significantly only when the cost of pilot training, accession through USMA, or increases in age of the KIA are assumed.

VII. SUMMARY AND CONCLUSIONS

A KIA results in two losses, a loss to the military and a loss to society. Both must be evaluated before the true cost of a KIA can be determined. The purpose of this study was threefold. First was the identification of those factors, relevant in a military context, of life valuation that could be quantified. It was shown that life value consists of two all-inclusive aspects, ethical and utilitarian, the latter being comprised of an emotional and economic component. It was found that even though the economic component was the only one that could be quantitatively evaluated, the emotional and ethical components could not be ignored. Previous attempts by the courts to evaluate these intangible components have not provided results that are amenable to the problem of evaluating the cost of a KIA. The approach taken by this study was that the evaluation of these intangible losses must be left to the subjective preferences of the decision maker.

The second purpose of the study was to develop a model for estimating the economic cost of a KIA. The economic loss to society was argued to be the present value of the lifetime income a KIA would expect to receive had he lived. It was later revealed that this loss accounted for the majority of the total cost of a KIA and was dependent upon the geographical region, age, and level of education of the KIA and the rate used to discount the income stream back to present value. The economic loss to the military was developed by considering a soldier as any other

resource, the loss of which could be evaluated as the replacement cost. Three broad replacement cost categories; procurement, training, and operating costs, were established and when summed gave the total economic loss to the military. This loss remained fairly constant and was sensitive only to the length of service of a KIA. In certain special situations, such as undergoing flight training and accession via USMA, the cost to the military was significantly increased. A model for estimating the total economic cost was derived as the sum of the loss to society and the loss to the military. Separate models were developed for an officer and enlisted KIA.

The final purpose of the study was to demonstrate the use of the cost model and to show by examples the upper and lower cost estimates of a KIA. A typical or average KIA, both of an officer and an enlisted man, was constructed by using Vietnam casualty reports. The age, grade, length of service, and geographical region of the average KIA were determined from these reports. This information, combined with existing data on average income, discount rate, and military costs were used as input data to the model and the cost of the average KIA was computed. The upper and lower cost estimates were found by manipulating the input data so as to produce the maximum and minimum costs.

The final section of the study was devoted to a limited sensitivity analysis. Certain of the model's parameters; age of the KIA, the discount rate, and the economic growth rates, were varied to determine the effects on the total cost. The total cost was sensitive to changes in all the parameters with the exception of the economic growth rates.

The information and material developed in this study leads to three major conclusions. First, the true cost of a KIA cannot be determined by quantitative analysis alone. The presence of intangible but relevant factors requires the use of subjective judgment. Secondly, the economic dollar cost of a KIA can be realistically estimated by a mathematical model and for planning purposes is considered to be approximately $180,000 for an officer KIA and approximately $100,000 for an enlisted KIA. Lastly, the cost figures derived will provide the Department of Defense decision makers with a workable cost estimate of a KIA and when combined with their evaluation of the intangible losses, will establish a systematic procedure for treating the problem of life evaluation.

The problem of determining the cost of a KIA has been presented, discussed, and a solution offered. In handling this problem, an attempt was made to determine both what should be done and how to do it. The final task of deciding how best to use the results of this study is summarized by the following:

"- - -while model building, which is to say quantitative analysis, can assist the decision maker, it must be tempered with experience, judgment, and intuition."[Ref. 16:330]

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Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)	2a. REPORT SECURITY CLASSIFICATION
Naval Postgraduate School Monterey, California 93940	Unclassified
	2b. GROUP

3. REPORT TITLE

The Cost of a KIA

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Master's Thesis; October 1969

5. AUTHOR(S) (First name, middle initial, last name)

Alton Hugh Coleman

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
October 1969	54	23

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)
b. PROJECT NO.	
c.	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)
d.	

10. DISTRIBUTION STATEMENT

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11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
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13. ABSTRACT

This study presents, discusses, and offers a solution to the problem of estimating the cost of a KIA. The different aspects of life valuation are discussed in terms of losses that result to both the military and to society in general when a soldier is killed. These losses are further identified as to whether they fall into one of two categories, tangible or intangible. Although the study is mainly concerned with the tangible losses, a procedure is offered that will ensure inclusion of the intangible losses in the overall cost determination of a KIA. For the tangible losses, a mathematical model is developed for computing the economic loss of both an officer and enlisted KIA to society and to the military. The use of the model is demonstrated by way of three examples, the first of which determines the cost of an "average" KIA and the remaining two determine the upper and lower cost bounds. A limited sensitivity analysis is conducted on the model and the results and the impact of the analysis is presented. The study concludes with how the model can best be used by Department of Defense decision makers.

DD FORM 1 NOV 65 1473 (PAGE 1)

S/N 0101-807-6811

Security Classification

A-31408

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
KIA						
Life Valuation						
Tangible loss						
Intangible loss						
Ethical						
Moral						
Emotional loss						
Economical loss						
KIA Cost Estimate						
Loss to Military						
Loss to Society						
Cost model						
Procurement Costs						
Training Costs						
Operating Costs						
Expected Lifetime Income						
Present Value						
Sensitivity Analysis						
Discount Rate						
Economic Growth Factors						